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ABSTRACT

To assist in the development of policies to eliminate the subtle inequities which inhibit the mathematics achievement of many Black youths, it is suggested that the redesign of the National Assessment of Educational Progress (NAEP) mathematics assessment study Black students' opportunity to learn mathematics. Recommendations for the redesign of the NAEP mathematics assessment and its reporting formats are based on a cross-sectional study of mathematics achievement data on 14,289 Black, White, and Hispanic 17-year-old students from the third NAEP assessment. Achievement on the algebra or pre-algebra subtests was evaluated against mathematics course enrollment. Other variables studied included grade level, school racial composition, curriculum type, achievement level, race or ethnicity, and affective responses. Results indicated significant racial and ethnic differences in enrollment by curriculum (general versus academic) and in achievement. Schools' racial composition also appeared to affect achievement. Preliminary test item analysis suggests the need to use additional criteria in determining item bias for Blacks. Because it is a valuable database for research, it is strongly recommended that NAEP broaden its scope to include measures of the opportunity to learn mathematics as a standard variable and to report school achievement impacted by school culture, classroom processes, and significant others. It is further recommended that NAEP restructure cognitive items on which Black students perform poorly to explore the causes for these response patterns. Changes in NAEP's affective and background measures are also proposed. (GDC)

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Proposals for Improving the NAEP Mathematics Assessment of Black Youth

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PROPOSALS FOR IMPROVING THE NAEP MATHEMATICS ASSESSMENT OF BLACK YOUTH

A Paper Commissioned By:

The Study Group on The National Assessment of Student Achievement

August 27, 1986

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Proposals for Improving the NAEP Mathematics Assessment of Black Youth

Introduction

The reconstruction of the National Assessment of Educational Progress (NAEP) mathematics assessment to allow for substantial educational policy research is critical to enhancing opportunities for Black youth to achieve in mathematics. Findings of what all (most, and some) students know in mathematics and changes in the extent of this knowledge by cognitive process levels over time are well documented in traditional "NAEP Report Cards" to the nation. However, these reports cards do not yield results from which policy can be directed to eliminate the subtle inequities which inhibit the mathematics achievement of large numbers of Black youth.

To achieve this end, equity issues must be incorporated into the NAEP design. The aim is neither to politicize the NAEP, nor to promote increased scores for Blacks at the expense of other students. Conversely, the aim is to ensure that achievement gains (losses) are reported as a function of changes in opportunity to learn. Accordingly, the purpose of this paper is to create the awareness of the need for NAEP to identify, clarify, obtain measures (certainly to be crude measures initially), and provide reports to the nation of the extent of the opportunity Blacks have to learn the mathematics content on which they are being assessed.

This paper is not concerned with how educators, policy makers, test directors, and others implement these results. Rather, the scope of this paper is limited to proposals for the redesign of the NAEP mathematics assessment and its reporting formats. These recommendations are based on this author's experiences in completing the study, The Effect of Mathematics Course

Enrollment on Racial/Ethnic Differences in Secondary School Mathematics Achievement (1986), conducted while she was a visiting scholar at the NAEP Center at the Educational Testing Service (ETS), Princeton, New Jersey. This cross-sectional, atypical study of NAEP data focused exclusively on racial/ethnic differences in mathematics achievement which occurred during one assessment year, the third assessment (data from the fourth assessment are not yet in the public domain).

Highlights of The Research Study

Methodology and Variable Identification

Seventeen-year-old students who participated in the NAEP third mathematics assessment constituted a nationally representative sample of 14,289 students of whom 76% were white, 16% were Black, 6% were Hispanic, and 2% were "other race." In that this study focused on black, white, and Hispanic students, the latter group was excluded from consideration.

NAEP cognitive items in Booklets 7 through 13 were classified as pre-algebra or algebra depending on the content and indicated skills. Achievement on these item sets was evaluated against the respondents' self-reported mathematics training. The primary independent variable, then, was "Course Enrollment." For ease of analysis, course sequences were labeled as follows (students were assigned according to whether they indicated having studied each course in the sequence for at least one-half year):

A - Algebra 1, geometry, Algebra 2, trigonometry;

B - Algebra 1, geometry, Algebra 2;

C - General Business, Algebra 1, geometry;

D - Algebra 1, geometry;

E - General Business, Algebra 1;

F - Algebra 1 only;

G - General Business only; and

H - No mathematics courses;

Other independent variables examined were: grade level, racial composition of the school, curriculum type, achievement level, race/ethnicity, and affective measures. The dependent variable was the mean percentage of correct responses to the algebra or pre-algebra subtests. Also, in the affective domain, the dependent variable was the weighted mean proportion of responses to Likert-type affective exercises.

Analysis of the Data

The NAEP sampling technique involved the selection of groups of students from the same school; thus, observations were not independent of each other. A procedure developed by The Education Commission of the States was used to adjust ordinary formulas based on the assumption of simple random sampling (Johnson 1980). Significance tests were conducted for α = .01.

Results of the Study

Inequitable Access

Significant racial/ethnic differences in enrollment by curriculum were found. Blacks were slightly more likely than whites (47% versus 43%) to be enrolled in the general curriculum. However, white students were substantially more likely than Black students (46% vs 36%) to be enrolled in the academic curriculum. It is of interest to note that among students enrolled in the academic curriculum, 55% of the Blacks, compared to 79% of the whites, were enrolled in advanced mathematics courses (Sequences A - D). As shown in Figure 1, fewer than 12% of this number were enrolled in Sequence A, the highest and most advanced level. Of the students within the academic curriculum who had

not studied any high school mathematics, 32% were Black.

Figure 1 Here

Differential Mathematics Proficiency

By concepts and courses. Even though persistence in the study of advanced mathematics increased proficiency in pre-algebra and algebra, regardless of race, significant racial differences in achievement were found. For example, the pre-algebra test measured: the recall of operations with integers, decimals, and fractions; knowledge and understanding of measurement-related concepts; skills in problem solving, geometry, probability, and the interpretation of graphs and charts. Outcomes on this test revealed a large and significant racial difference of 19%. This difference represented nearly two standard deviational units in the pre-algebra proficiency of white students over Blacks. The algebra test consisted of elementary concepts generally taught at the ninth grade level. The large and significant achievement gap of 17% on the algebra test represented a difference of one standard deviation in the proficiency of whites over Blacks.

As shown in Figure 2, racial differences in achievement on the Total Test (the combined pre-algebra and algebra test) increased as the difficulty level of the courses increased. In standard deviation units, this differential was 1.0 at Sequence D and increased to 1.5 for students enrolled at the level of Sequence A.

Figure 2 Here

FIGURE - 1

Academic Curriculum
Mathematics Course Enrollment Pattern
by Race/Ethnicity

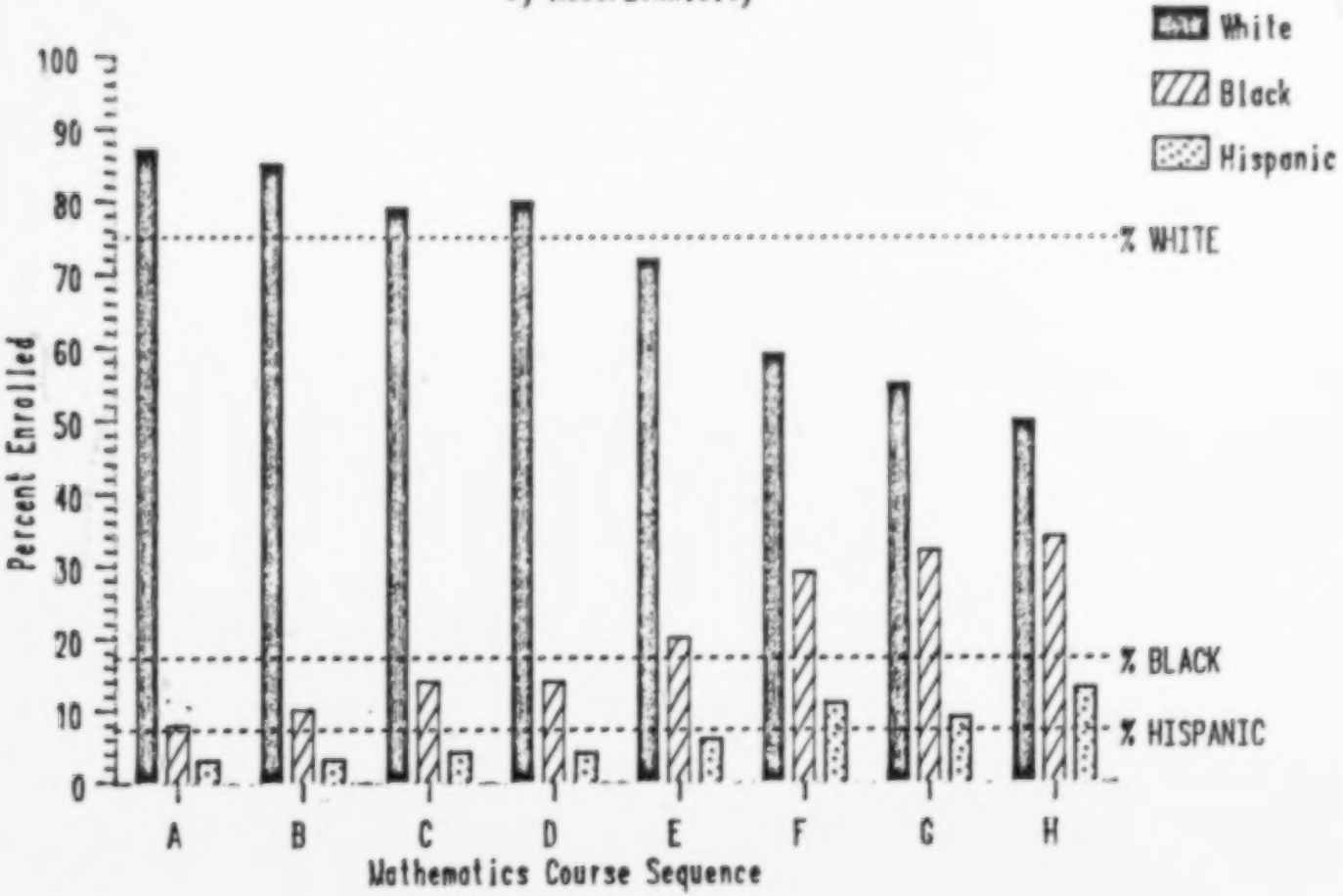
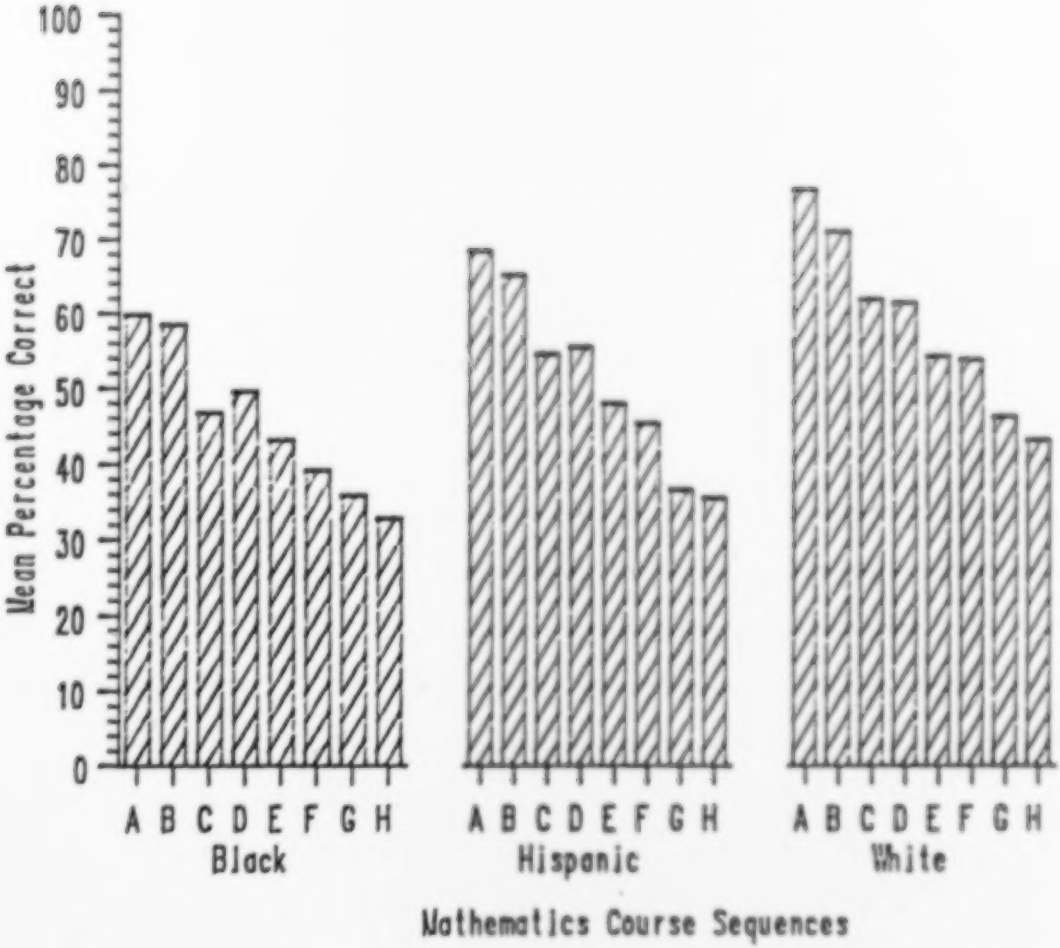


FIGURE - 2

Performance on Total Test by Race/Ethnicity



By schools. Attending predominantly black high schools promoted slightly higher, although not significant, increases in the enrollment of Black students in advanced mathematics courses. But attending predominantly white high schools increased the achievement outcomes for whites and Blacks at levels significantly higher than their racial counterparts in predominantly black high schools.

Related Findings

The author is currently analyzing items of the NAEP mathematics assessment to examine more specifically the problems encountered by Blacks. Preliminary findings show a pattern of reduced proficiency on items containing multiple parts. Even when the arithmetical operation remained the same, the majority of Black students were unable to complete items after the second problem of a multiple-part item at a 70% proficiency level or better. Speed was not a factor. Proficiency was low, too, on problems which: a) required the interpretation of graphs and charts; b) required the development or use of a model; c) required knowledge of formulas, and d) involved two-step problem solving.

The existence, then, of disproportionately more NAEP mathematics items for which the r-biserial correlational measure is less than 30 for Blacks compared to whites, is not surprising (NAEP normally uses this measure to eliminate "unfair" items). Despite this approach to statistically assuring a pool of unbiased items, outcomes for Blacks showed that 9% to 17% (compared to 3% average for whites) of the items within a given test booklet had r-biserials below 30. These items are generally characterized by their use of the term, "average." It obviously constitutes a word bias for Black students. This finding suggests the need to use additional criteria in

determining item bias for Blacks. NAEP, though, is to be commended for progress made in eliminating racial stereotyping in item types and in involving minorities in the construction of its assessment instruments.

Discussion

Collectively, the findings of this study suggest that the majority of Black youth are not enrolled in classes where mathematics is taught in academically challenging and stimulating ways. They do not, therefore, benefit from the use of enhanced instructional resources and experiences normally provided college-bound students in the academic curriculum. Still, Blacks, like other students, must be taught mathematics in academically challenging modes to better prepare them to enter mathematics-related vocations and careers in proportion to their representation in the general population.

Very little progress has been made in improving Black students' mathematical skills because research in this area has been relatively scarce and problematic. The fundamental problem of how to identify minority groups has yet to be resolved. In fact, most researchers are rarely certain whether the group is being defined by test scores, grade-level achievement, soci-economic status, or other measures. To the contrary, the literature on gender differences and on white students and mathematics has been systematically developed. It is no surprise, then, that mathematics reform has been historically normed on the well established research base on white students.

Chartered by the federal government to monitor the educational training of America's youth, NAEP could provide a valuable database for researching the mathematics proficieny of Black youth. Unlike the Scholastic Aptitude Test which is administered to the most capable students, NAEP is an achievement

test which is administered to "typical" in-school populations; its sampling of minority generally exceeds their representation in the general population. Moreover, the numerous replications of the NAEP design at state levels suggest the appropriateness of NAEP for making substantial contributions to educational policy, particularly policy governing the mathematics education of racial minorities. Thus, it is strongly recommended that NAEP broaden its assessment scope to include measures of the opportunity to learn mathematics as a standard variable. These measures should be included in a common core, and not a rotated battery to ensure adequate sample sizes.

NAEP should also broaden its reporting format. The traditional NAEP explanation of score differences on the basis of socio-economic status, race/ethnicity, and cognitive development does not readily translate into policy-regulating actions which can lead to programmatic changes. In addition to reporting achievement in the absolute, NAEP should also report achievement as impacted by such factors as school culture, classroom processes, and significant others. Until equity issues (in this case issues regarding the opportunity to learn mathematics) have been appropriately built into large-scaled instruments such as the NAEP, this nation can not benefit from a well-developed research base on the mathematics education of Blacks. Neither increased mathematics proficiency among Blacks, nor a sizeable decrease in the Black/white achievement gap in mathematics will likely occur.

Proposals for Change

Cognitive Items

As discussed previously, many Black students failed to complete all

components in multiple-part assessment items. They also performed poorly on measurement items requiring the recall of formulas. NAEP could restructure cognitive items in the interest of exploring possible causes for these response patterns. To determine the influence, for example, of the length of one's attention span on proficiency as measured by problems presented in multiple-item formats, the use of "matched" items is recommended. Such built-in controls could also promote the understanding of the influence of value judgement (such as the perception that materials easily retrievable from reference sources should not be committed to memory) on student achievement.

Providing measurement formulas in selected instances and assessing skills when these formulas are not provided would facilitate a better understanding of students' capabilities. Questions regarding reduced proficiency owing to controllable factors like these remain unanswered because NAEP does not in a given booklet, use items which would provide amplification of error patterns.

It is further recommended that selected cognitive items on which Blacks have repeatedly failed to achieve at the level of 50% or better be entered in subsequent assessments with accompanying background measures which monitor the:

1) students' familiarity with the content, format, and mode of presentation of the item;
2) use of extra-curricular activities and/ or instructional materials to enhance understanding
3) students' interests in solving the types of real-world problems presented.

These recommendations merit further study. However, they represent a

start in a much needed direction to ascertain what happens to blacks during their precollege mathematics training experiences.

Background and Affective Questions

The content of selected background questions and the procedure for eliciting responses to the affective questions do not yield useful information on Blacks. A typical background question which should be revised is the index of items in the home (encyclopedias, vacumn cleaners, books, magazine, etc.) as an SES measure. Many middle income Blacks have access to, but do not have encyclopedias in their homes. Although no specific recommendation for a replacement item is made, further study of the type reading materials Black families have in their homes or have access to is strongly encouraged.

NAEP included different sets of affective measures in different booklets. The net result was that in a sample of 2000 students, approximately 200 of whom were Blacks, not enough Blacks were included to draw reasonable inferences on their motivations and aspirations in mathematics by racial composition of the school or by race and gender status. Because the affective items were not administered to all respondents, analyses at increasing levels of details were not possible. The cross tabulations either yielded empty cells or N's that were too small for analyses. It is important, then, to include affective measures on Blacks in a core battery rather than a rotated format to eliminate this problem.

Proposals for improving the content of affective and/or background measures to better meet the needs of Black youth include the use of measures of the student's perceptions of:

1) their teacher's expectations for them to learn mathematics;
2) the procedures, methods, programs, etc. used by the school, teacher, etc. to encourage persistence in the study of mathematics;
3) explanations of poor mathematics achievement in school (to include information on the number of repeated courses in mathematics);
4) exclusionary (encouraging) tactics which instructors use to discourage (encourage) their participation in the mathematics classroom; and
5) the role of their families in assisting with mathematics homework and in encouraging them to study mathematics.

Answers should also be sought to the following:

1) measures which are used for advising students into mathematics courses; and
2) measures which differentiate the influence of letter grades from personal motivation and/or social utility for studying mathematics.

Conclusion

Black high school students constitute an underrepresented group in mathematics. School-related barriers which communicate messages of " being poor in mathematics" work together with other forces to preclude Black students' access to advanced mathematics courses. Like other students, Blacks should be taught mathematics in academically challenging modes to better prepare them to enter mathematics-related vocations and careers in proportion to their representation in the general population.

Barriers such as: discriminatory content in the formal and informal curriculum; testing and advisement practices which discriminate often by exclusion; and negative teacher behaviors can be addressed by policy.

Policy makers, however, need access to a knowledge base which is the by-product of well-focused and systematically conducted research. Such access will promote improved decision-making capabilities in the effort to improve the quality of mathematics education of Black youth in America. NAEP can make a valuable contribution in this regard.

NAEP should, in fact, be more integrally involved in monitoring the access to learning, and the in-class, as well as, in-school experiences of the nation's youth, given the national demands for school accountability, as expressed, for example, in the Nation at Risk (National Commission on Excellence in Education 1983). In this time of shrinking federal dollars for compensatory education and during this time when educators, administrators, curriculum supervisors, interested lay persons, and policy makers frequently use test data to justify such decisions as program expansion or deletion, student advancement or retention, and the construction or closing of school facilities, "fairness" in testing is an issue of major concern for Blacks. NAEP should, then, seek to incorporate and to clarify through subsequent assessments the opportunities that all students have to learn mathematics. In this way, policy makers and other concerned individuals will be able to use their powers more perceptively in judging and in creating opportunities for Black youth to achieve in mathematics.

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